Evaluation of Inter-laboratory Comparisons

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Abstract: Under evaluation of inter-laboratory comparisons (ILC) is understood the statistical determination of estimates of the mean value (value of the true measured quantity in specific cases referred to as reference value), variance components (which are within-laboratory and between-laboratory variances) and their confidence intervals. The model for evaluation of inter-laboratory comparison in this study (my PhD thesis) coincides with the mixed linear model with one factor $\boldsymbol{a}$ (laboratory):

$$\boldsymbol{Y} = \boldsymbol{1}\mu + \boldsymbol{a} + \boldsymbol{e}.$$

$\boldsymbol{Y}$ represents measurement series vector of the true value of the measured quantity $\boldsymbol{\mu}$ in individual laboratories. $\boldsymbol{e}$ stands for random quantity of errors.

The factor $\boldsymbol{a}$ can be understood either as a fixed effect or a random effect (random effect model). If we suppose $\boldsymbol{a}$ to be random and the measurements are normally distributed with mean m (the true measured value) and dispersion $s_{\mathrm{L}}^2 + s_{ei}^2$, where s_{L}^2 being the inter-laboratory variance and s_{ei}^2 the within-laboratory variance of i^{th} laboratory. In the model with one random effect we try to estimate the variability of random effect, so of inter-laboratory variance s_{L}^2. If $s_{\mathrm{L}}^2 = 0$, the random effect laboratory does not have any influence on results.

In the first step of ILC evaluation we test the requirement of normal probability distribution of measurements and the homoscedasticity of measurements that is the achievement of comparable within-laboratory variances (repeatability) of measurements in individual laboratories.

My PhD thesis allows one to determine the consensus value for a large class of ILC models also for heteroscedastic measurements when introducing uncertainty evaluated by means of method type B.

Based on a study of simulated experiments with heteroscedastic measurements it can be shown that the use of any one of the three following methods: maximum likelihood, Mandel-Paule and modified Mandel-Paule, to evaluate ILC is appropriate.

The influences of variance components (between laboratory variance based on the Burdick-Eickman estimate) on the consensus value for heteroscedastics measurements has been also studied.

Presenting Author's information

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Curriculum Vitae
of Adriana Horníková

- 1973: Born in Bratislava, Slovak Republic

Education and Long Term Employment

- 1980 - 88: Elementary/primary school in Bratislava
- 1988 – 92: Grammar school in Bratislava
- 1992 – 97: Slovak Technical University in Bratislava Faculty of Mechanical Engineering, studying later at Department for Measurement and Automation
- 1992-2000: Comenius University in Bratislava, Faculty of Natural Sciences studying chemistry and biochemistry
- 1997-2002: Slovak Technical University in Bratislava Faculty of Mechanical Engineering in Metrology
- Since 2001- : I work as a university teacher at the Dept. of Statistics at the Faculty of Economics Informatics at University of Economy in Bratislava
- 2003: Education to certified Quality Auditor at TU Wien (the University of Technology in Wien, Austria at the Faculty of Mechanical Engineering dep. for interchangeable manufacturing and metrology (Prof. P. H. Osanna)).

Studies abroad and visiting posts:

- 1991: Grammar school in Wien, Austria
- 1995-96: University of Technology in Wien, Austria at the Faculty of Mechanical Engineering in an interdisciplinary area of Biomedical Engineering (tutor: Prof. H.P. Troger).
- 1998-1999: student exchange stay at Swiss Federal Institute of Technology ETH in Zurich, Switzerland (tutor: Doc. Dipl. Ing.-ETH K. H. Ruhm), project on dynamical force calibration.
- 2002-2003: several distinguished visits at the University of Technology in Wien, Austria at the Faculty of Mechanical Engineering dep. for interchangeable manufacturing and metrology (Prof. P. H. Osanna)
- 2003-2004: foreign guest researcher at NIST (Statistical Engineering Division) in Gaithersburg, MD, USA.

Academic Titles

- 1997: Ing (Engineer of Mechanical Engineering)-eq. to Master of Engineering
- 2000: Mgr (Magister in Natural Sciences)-eq. to Master of Natural Sciences
- 2002: PhD (Philosophiae doctor).

Teaching Experience

- Since 1998 at the Faculty of Mechanical Engineering, Slovak Technical University in Bratislava in:
  - Design and Evaluation of Measurement,
  - Quality Assurance of Measuring and Information System,
  - Measurement Theory, Experiment and Signal Processing,
  - Measurement and Automatic Control,
  - Informatics,
  - Programming Languages (Turbo Pascal),

- Since 2001 at the Faculty of Economics Informatics at University of Economy in Bratislava in:
  - Statistics (fundamentals).

Research Interests:
- uncertainty evaluation on hydraulic elements
- quality assurance and measurement process control
- dynamic calibration of force sensor
- statistical analysis, testing and design
- inter-laboratory comparison, consensus value, repeatability and reproducibility

International Co-operation:
- International Project within the framework of grant of European Training Foundation (ETF), namely Tempus Institution Building Project IB-JEP-13 250/98 *Education and Training in Accreditation and Certification (EDUTRAC).*

Institutional Projects of the Slovak Research Agency VEGA:
- 01/4157/97 Testing and Calibration of Multicomponent Sensors;
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Selected Publications:
Books (1): Palencár, R., Ruiz, J. M., Janiga, I., Horníková, A. to the topic "Statistical Methods in Metrological and Testing Laboratories", Graphic studio Ing. P. Juriga, 2001 Bratislava (ISBN 80-968449-3-8).
Evaluation Guide: Palencár, R., Horníková, A.: (Inter-laboratory comparison of transformation oils testing / Statistical Evaluation) 1999, SjF STU Bratislava.
Workshops contributions (17):

- Horníková, A., Palencár, R., Wimmer, G.: Mathematical Models for Inter-laboratory Comparison. Workshop on Advanced Robot Systems and Virtual Reality, ISMCR´2000, 28-30 September 2000, Vienna-Austria. XVI IMEKO WORLD CONGRESS IMEKO 2000, PROCEEDINGS Vol. XI: p. 133-138
- Horníková, A.: Mathematical Model for Inter-Laboratory Comparison. 2nd Proceedings, April 26-29, 1999 Smolenice SR. (eng.)
- Horníková, A.: Evaluation of Consensus Values, In: Strojné inžinierstvo '98, p. 505-508.
- Horníková, A., Palencár, R., Wimmer, G.: Inter-laboratory Comparison Methods In: Strojné inžinierstvo ´2000.
- Palencár, R., Chudý, V., Horníková, A.: Further Dissemination of the EDUTRAC Project Results (Training Activities of Slovak Technical University Faculty of Mechanical Engineering Dep. of Automation and Measurement for the year 2001 as the Output of International TEMPUS Project).
- M.N.Durakbasa: Developments of surface measurement and evaluation of biomedical structures, Trendy Rozvoja Biomedicínskeho Inžinierstva Konferencia s medzinárodnou úcastou poriadaná pri príležitosti osláv 50. výrocia založenia Strojníckej fakulty TU v Košiciach a 15. výrocia zriadenia študijného odboru "Biomedicínske inžinierstvo", Hotel SLOVAN, Tatranská Lomnica, Máj 22 – 23, 2002.
- Ing., Mgr. Adriana Horníková: International Standards (CEN and ISO) and their Transfer into Slovakian Norms, International Quality Days Pristina, Kosova 27-29 September 2002.
- P. Herbert Osanna, Peter Kopacek, Adriana Hornikova: Automation Education in the EC from the Viewpoint of SME`s, Co-ma-tech 2002, 24-25 October 2002.
- Ing., Mgr. Adriana Horníková: International Standards (CEN and ISO) and their Transfer into Slovakian Norms, Co-ma-tech 2002, 24-25 October.
- Horníková: Analysis of Measurement of Inter-Laboratory Comparison through Confidence intervals, XVII IMEKO World Congress, June 22-27, 2003 Dubrovnik Croatia, pp. 1284-1288.
- A. Horníková: Evaluation of Inter-laboratory Comparison, Proceedings of the 4th International Conference on Measurement, June 15-19, 2003 Smolenice SR, pp. 51-54.
- M. Numan Durakbasa, P. Herbert Osanna, Adriana Hornikova: Biomedical Application of Form Measurement and Coordinate Metrology, 2003 (in preparation)
- P. H. Osanna, A. Janac, M. N. Durakbasa, A. Hornikova: Modern Design and Manufacturing on the Basis of Developments in Nanotechnology, 2003 (in preparation)